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(54) **GENERATION OF HIGH OCTANE HYDROGEN GAS FROM ACETIC ACID**

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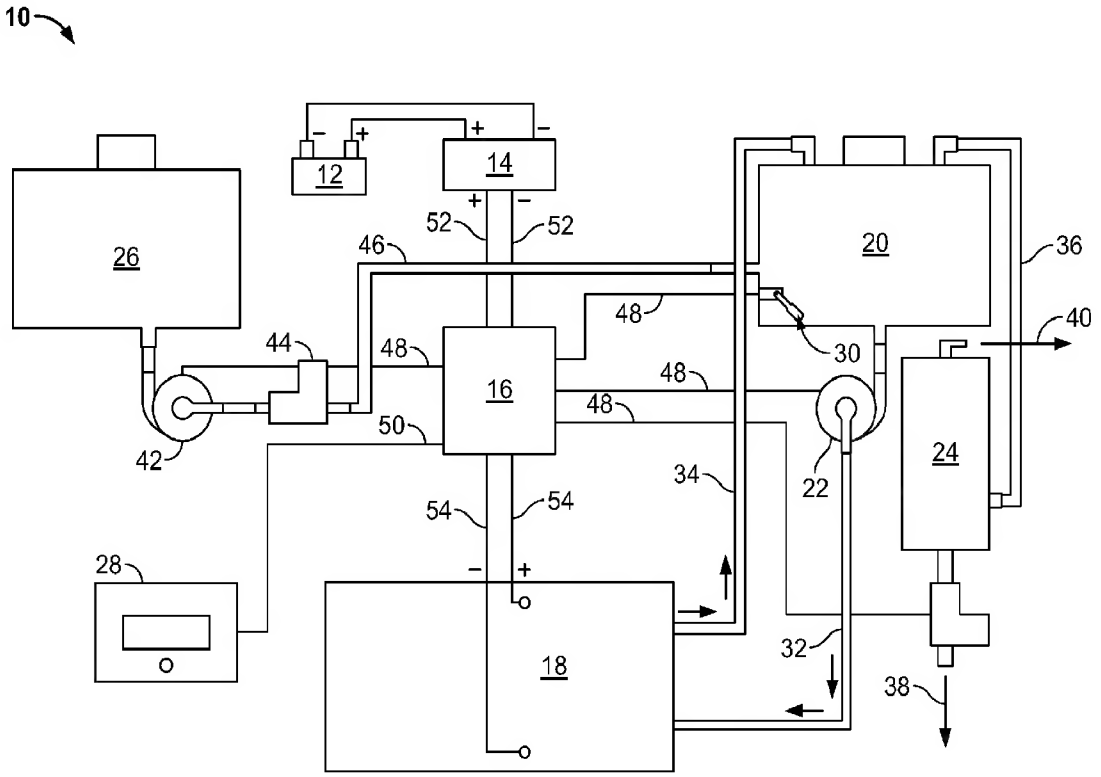
(57) **ABSTRACT**

A device and method for generation of high octane hydrogen gas from acetic acid includes providing an electrolysis unit having a cathode, an anode, neutral elements, gaskets, and an electrolyte including acetic acid; applying pulse-width-modulated power to the cathode and anode to produce hydrogen and oxygen gas from the electrolyte; transporting the gas and some of the electrolyte from the electrolysis unit to a reservoir; transporting the electrolyte in the reservoir back to the electrolysis unit, thereby reusing the electrolyte; refilling the reservoir with distilled water when the level of electrolyte in the reservoir is low; utilizing a condensate trap to dump water that condenses out of the gas in the reservoir; and transporting the gas in the condensate trap for use. The hydrogen and oxygen gas may be provided to the air intake of an engine.



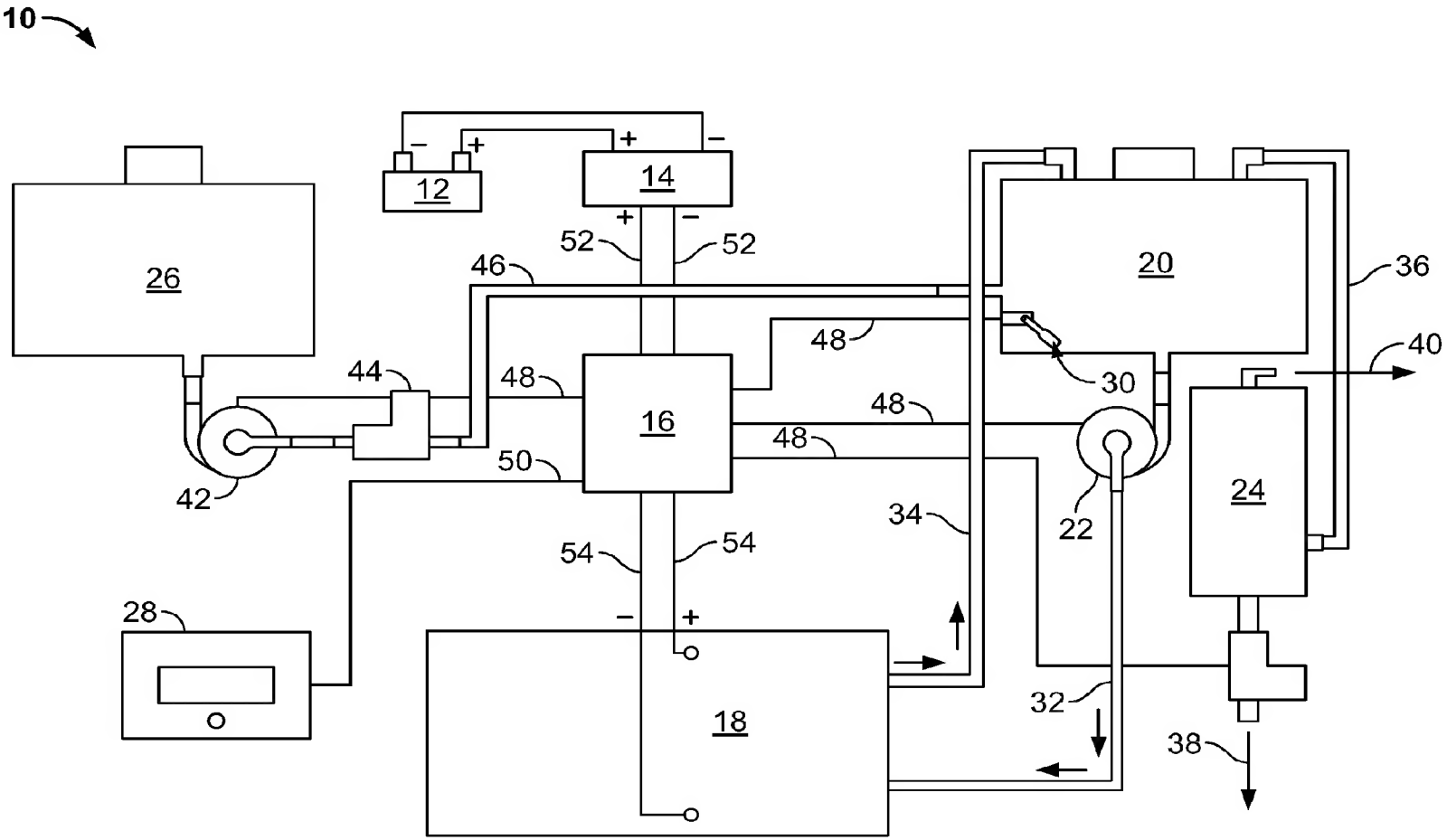


FIG. 1

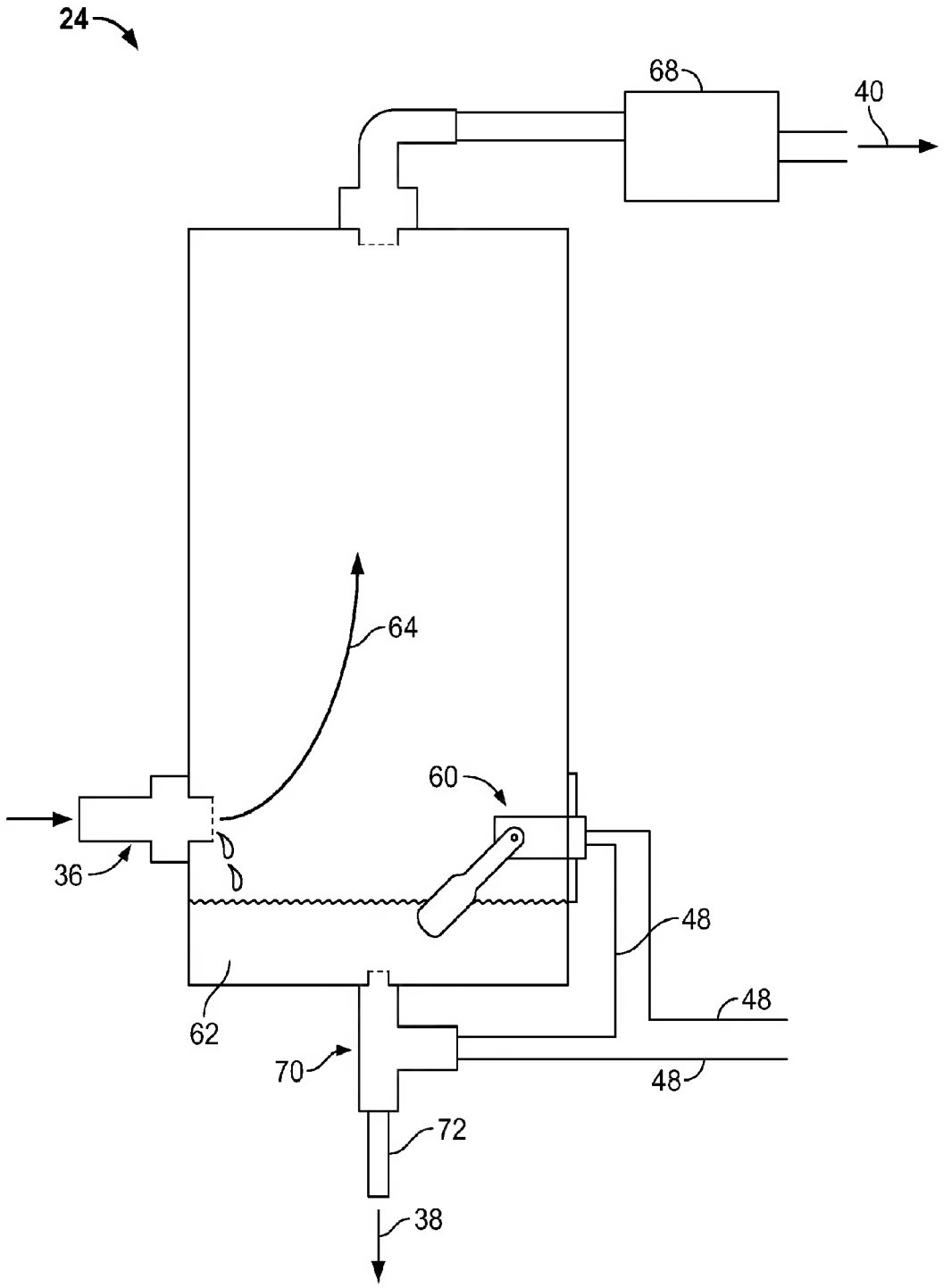


FIG. 2

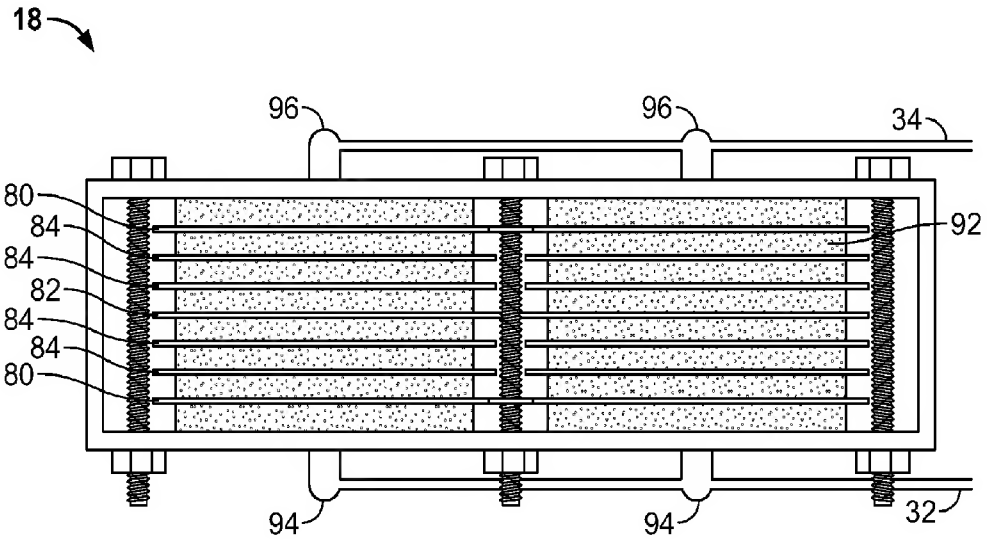
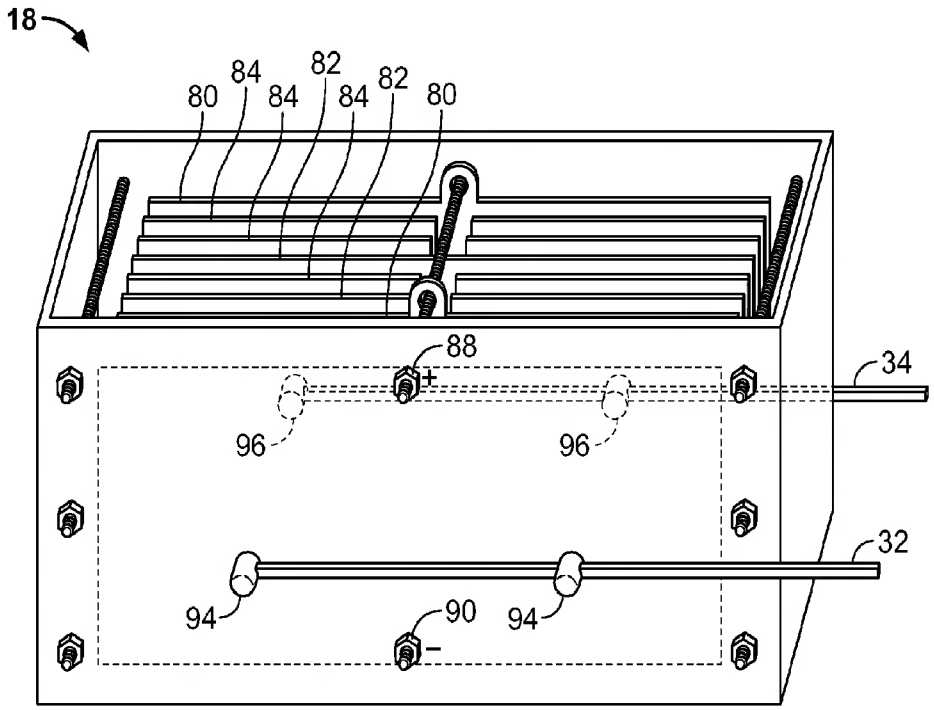

18
96
96
34
80
84
84
82
84
84
80
92
94
94
32

FIG. 3A


18
80
84
84
82
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82
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88
+
34
96
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32
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90
94
−

FIG. 3B

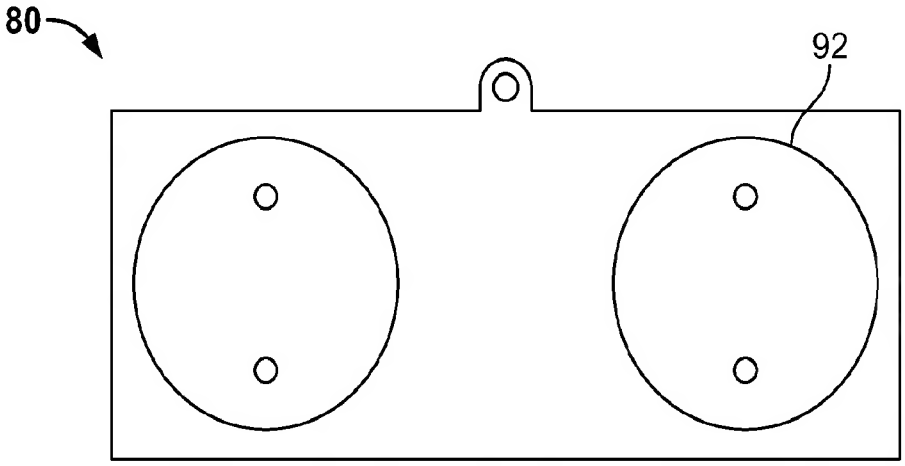

FIG. 4A

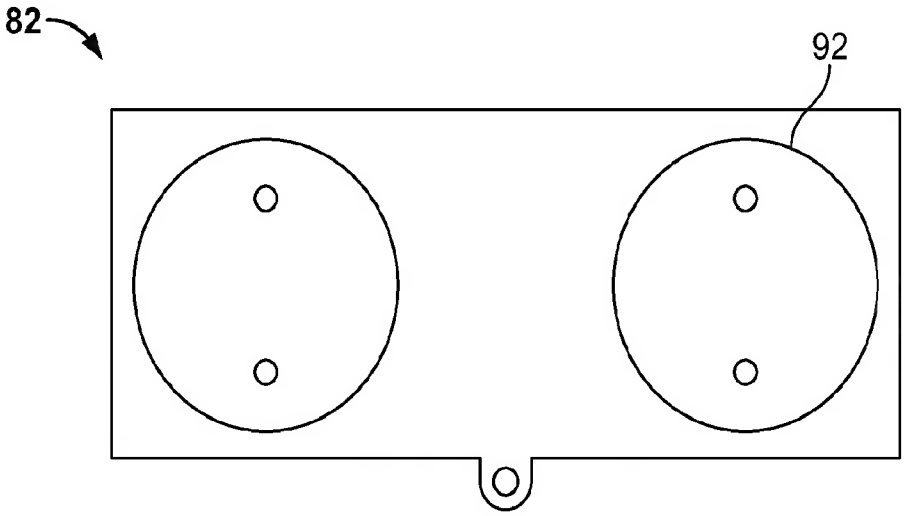

FIG. 4B

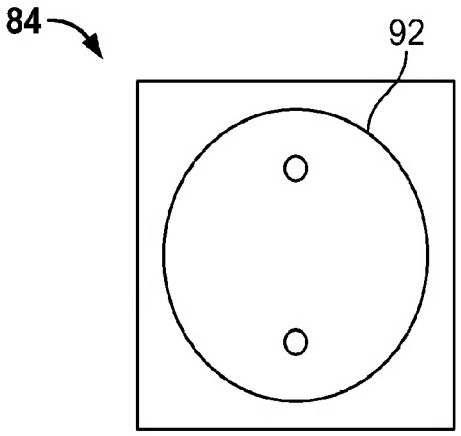

FIG. 4C

GENERATION OF HIGH OCTANE HYDROGEN GAS FROM ACETIC ACID

RELATED APPLICATIONS

[0001] This application claims the benefit of the filing date of U.S. Patent Application No. 61/224,194, filed Jul. 9, 2009, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] The present invention generally relates to generation of hydrogen gas and more specifically to generation of high octane hydrogen gas from acetic acid.

[0003] Existing internal combustion engines for automobiles may burn only 20% of the carbon in the gasoline or diesel fuel. Carbon is sent to a catalytic converter, which is wasteful, and produces emissions that include noxious gasses and green house gasses, such as carbon monoxide (CO), carbon dioxide (CO2), and nitrous oxide (NO).

[0004] The use of on-board electrolysis in producing small amounts of hydrogen and oxygen gasses into the air intake of an internal combustion engine may increase mileage and reduce emissions from the automobile.

[0005] It would be therefore be desirable to have a device that may be useful to an individual, business or corporation who desires or needs a reduction in fuel consumption and has a desire to reduce emissions, such as, for example trucking companies, police departments, school systems, individuals who commute to and from work, and others who wish to reduce emissions.

SUMMARY OF THE INVENTION

[0006] In one aspect of the present invention, a device for producing a gas includes an electrolyte; an electrolysis unit that retains the electrolyte; a cathode inside the electrolysis unit; a positive lead electrically connected to the cathode; an anode inside the electrolysis unit; a negative lead electrically connected to the anode; a neutral element inside the electrolysis unit, between the cathode and anode; a pulse width modulator that provides pulse-width-modulated power to the leads so that the cathode and anode react with the electrolyte to produce a gas; a first conduit that transports gas and electrolyte in the electrolysis unit to a reservoir; a second conduit that transports the electrolyte in the reservoir to the electrolysis unit; and a third conduit that transports the gas in the reservoir out of the device, thereby producing the gas.

[0007] In another aspect of the present invention, a device for producing a gas includes an electrolysis unit that retains an electrolyte, the electrolyte including acetic acid; a cathode inside the electrolysis unit, having a metal plate and a cathode tab electrically connected to a positive lead; an anode inside the electrolysis unit, having a metal plate and an anode tab electrically connected to a negative lead; a neutral plate between the cathode and anode, the anode, cathode, and neutral plate oriented generally parallel to each other inside the electrolysis unit; a plurality of gaskets between the plates; a pulse width modulator that provides pulse-width-modulated power to the leads so that the cathode and anode react with the electrolyte to produce a gas that includes hydrogen and oxygen; a first conduit that transports gas and electrolyte in the electrolysis unit to a reservoir; a second conduit that transports the electrolyte in the reservoir to the electrolysis unit; and a third conduit that transports the gas in the reservoir out of the device, thereby producing the gas.

[0008] In yet another aspect of the present invention, a method of producing a gas includes providing an electrolysis unit having a cathode, an anode, a neutral element between the cathode and anode, gaskets therebetween, and an electrolyte including acetic acid; applying pulse-width-modulated power to the cathode and anode to produce gas from the electrolyte, the gas substantially containing hydrogen and oxygen; transporting the gas and some of the electrolyte from the electrolysis unit to a reservoir; transporting the electrolyte in the reservoir back to the electrolysis unit, thereby reusing the electrolyte; refilling the reservoir with distilled water when the level of electrolyte in the reservoir is low; utilizing a condensate trap to dump water that condenses out of the gas in the reservoir; and transporting the gas in the condensate trap for use, thereby producing the gas.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** depicts a schematic depiction of an embodiment of the present invention;

[0010] FIG. **2** depicts a condensate trap according to the embodiment of FIG. **1**;

[0011] FIG. **3**A depicts a top view of an electrolysis unit according to the embodiment of FIG. **1**;

[0012] FIG. **3**B depicts a side view of the electrolysis unit of FIG. **3**A;

[0013] FIG. **4**A depicts a positive plate according to the embodiment of FIG. **1**;

[0014] FIG. **4**B depicts a negative plate according to the embodiment of FIG. **4**A; and

[0015] FIG. **4**C depicts a neutral plate according to the embodiment of FIG. **4**A.

DETAILED DESCRIPTION

[0016] The preferred embodiment and other embodiments, which can be used in industry and include the best mode now known of carrying out the invention, are hereby described in detail with reference to the drawings. Further embodiments, features and advantages will become apparent from the ensuing description, or may be learned without undue experimentation. The figures are not necessarily drawn to scale, except where otherwise indicated. The following description of embodiments, even if phrased in terms of "the invention" or what the embodiment "is," is not to be taken in a limiting sense, but describes the manner and process of making and using the invention. The coverage of this patent will be described in the claims. The order in which steps are listed in the claims does not necessarily indicate that the steps must be performed in that order.

[0017] An embodiment of the present invention generally generates high-octane hydrogen gas from acetic acid. Embodiments may provide, for example, 115 octane hydrogen gas. Embodiments may be self-contained units that, when connected to an automobile or other vehicle's battery and engine air intake, provide hydrogen gas to improve mileage and reduce emissions.

[0018] An embodiment of a device may burn fuel that is otherwise normally exhausted. The device may generate high-octane hydrogen gas that is used by the motor. An embodiment may use electrolysis of acetic acid and other chemicals to generate, for example, 115 octane hydrogen gas at 5 pounds per square inch. Elements of an embodiment of the device may include a polycarbonate resin thermoplastic, such as, for example, Lexan®, which houses stainless steel

plates and silicone gaskets. Steel bolts may be used for assembly. Electrical terminals may be made of brass. Tubing for acetic acid circulation may include polyurethane, such as, for example, Superthane®. A reservoir may contain acetic acid used for the electrolysis. A circulation pump for the acid may be 12 volt, and may be driven by the automobile battery. Hydrogen gas or vapor may be generated by electrolysis. Gaskets may provide insulation. The acetic acid may be circulated and reused. Embodiments may produce hydrogen gas, which is collected and output.

[0019] Embodiments may introduce hydrogen gas into the air intake of an internal combustion engine, such as an engine for an automobile that uses gasoline, diesel fuel, natural gas, or propane. The hydrogen may help provide a complete and rapid burn of all carbon in the fuel for the engine, which may improve mileage and reduce emissions of emitting noxious gasses and green house gasses including carbon monoxide, carbon dioxide, and nitrous oxide. The hydrogen may be produced through electrolysis or hydrolysis, by a system operated from the automobile battery. The hydrogen may be produced on demand, only when the automobile is on, and thereby avoid the need for a dedicated gas holding tank.

[0020] As depicted in FIG. **1**, an embodiment of a system **10** may utilize a battery **12**, such as a 12-volt automobile battery or a dry cell, electrically connected to a relay **14**. Battery **12** also provides power to a system controller/pulse width modulator (PWM) **16**. Embodiments of PWM **16** may incorporate other functions of the system, such as relay **14**. PWM **16** may be a pre programmed microcontroller or other computer, and may provide pulse-width modulated power to an electrolysis unit **18**, which is a fuel cell or hydrogen-cell that utilizes an electrolyte such as acetic acid for hydrolysis. Gaseous hydrogen, oxygen, and aerosol electrolyte from the electrolysis unit **18** may be delivered to a reservoir **20**, which is a tank for electrolyte to be re-used, and gasses to be externally output. Condensed liquid electrolyte in the reservoir **20** may be returned to the electrolysis unit **18** as needed using a circulation pump **22** that runs continuously. The hydrogen and oxygen gasses in reservoir **20** may be provided to a water condensate trap **24** which may be delivered as an external fuel output **40** to the air intake of an internal combustion engine. Excess water **38** formed by condensed hydrogen and oxygen in the water condensate trap **24** may be dumped as needed. To replace this dumped excess water **38**, distilled water may be provided to the reservoir **20** from a reserve water tank **26** as needed. A dashboard unit **28** may display system status from PWM **16** and receive control inputs from a user. Pump **22** may continuously pump electrolyte from the reserve **20** to the electrolysis unit **18** through an electrolysis recharge line **32**. This may help blow the bubbles of hydrogen and oxygen off of the plates in the electrolysis unit **18**, as well as help provide pressure to urge the mixture of hydrogen, oxygen, and electrolyte to pass through the electrolysis recharge line **32**.

[0021] The level of acetic acid or other electrolyte in the reserve **20** may be detected by an electrolyte float switch **30**, and if the level is low, a reserve water tank **26** located adjacent or near the reservoir **20** may pump distilled water with a water pump **42** through a water valve **44** into a water pipe **46** and into the reservoir **20**. The addition of distilled water from water valve **44** may be controlled by PWM **16** based upon signals received from electrolyte float switch **30**. The gasses produced by the electrolysis unit may be collected and provided to the reservoir **20** through an electrolysis gas line **34**. Hydrogen and oxygen in the reservoir **20** may be provided to the water condensate trap **24** through a hydrogen and oxygen fuel line **36**. Power and control lines **48** may provide status information to the controller/pulse width modulator (PWM) **16** from components of the system, which may include the reserve water tank's water pump **42** and water valve **44**, the reservoir **20**, the circulation pump **22**, and the water condensate trap **24**. This status information may be interchanged using a data line **50** with a dashboard unit **28**, so that a user may provide control inputs to adjust the proportions and balances of the system. An embodiment of a PWM **16** may receive direct current (DC) power **52** such as 12-volt DC power from an automobile battery **14**, and provide pulse-width modulated power **54** to the electrolysis unit **18**. Embodiments of electrolysis unit **18** may be determined by the size of the internal combustion engine, which may be, for example, 4-cylinder, 6-cylinder, 8-cylinder, or diesel.

[0022] An embodiment of a pulse width modulator **16** may be used to control the amperage and voltage sent to the electrolysis unit **18**. In some embodiments, the PWM **16** rate may range from 300 to 3,000 pulses per second. The amperage may control both the supply of hydrogen gas produced and the amount of heat built up in the unit. An embodiment of a PWM **16** may function to help retard heat. The greater the amperage, the more hydrogen gas will be produced.

[0023] An embodiment of a dashboard unit **28** may be a free-standing element that has a computer or other control mechanism which sets the desired amperage of the PWM **16**. Users may use the dashboard unit **28** to make changes. Dashboard unit **28** may include a display screen, such as a liquid crystal display (LCD), that tells the user if there is a failure at any point in the system, such as, for example, a low electrolyte level in the reservoir **20**. The dashboard unit **28** may also indicate the electrolyte temperature, and might shut the system down for a period of time or decrease the amperage.

[0024] Embodiments may provide automatic refill, in that an extra reserve water tank **26** distilled water may be kept adjacent to reservoir **20**. When the level of acetic acid becomes low in reservoir **20**, electrolyte float switch **30** in the reservoir **20** tank electrically trips, which triggers water pump **42** and water valve **44** to transfer fresh distilled water from reserve water tank **26** to reservoir **20**. When replenished, water pump **42** shuts off and water valve **44** closes.

[0025] In an embodiment, acetic acid at 5% strength by volume may be stored in the electrolysis unit and may be used as an electrolyte because it is chemically stable, safe for humans, safe for the environment, and safe for internal combustion engines. The resulting hydrolysis product may help burn carbon build up which may have accumulated over years and may improve engine performance. Metal plates may be used to accomplish hydrolysis, and may be titanium coated with iridium tin, or ceramic covered stainless steel plates, or possibly plain stainless steel plates. However, the latter choice may produce hexavalent chromium which may be considered toxic in some areas, such as California. To perform hydrolysis, the electrolyte, such as 5% acetic acid with distilled water, may enter an embodiment of a dry electrolysis unit and may be introduced to the plates. Some plates may have leads that are attached to the automobile's positive terminal, which may act as cathodes, and other plates may have leads that are attached to the automobile's negative terminal, which may act as anodes, and yet other plates may be neutral. Hydrogen atoms, having negative electrons, will arise at the cathodes, and oxygen atoms, having positive protons, will arise at the anodes.

[0026] As depicted in the embodiment of FIG. **2**, a water condensate trap **24** may receive hydrogen and oxygen gas from a fuel line **36**, dump excess water **38**, and deliver an external fuel output **40** to an outside entity such as the air intake of an engine. Power and control lines **48** may power and control a condenser float switch **60** that measures the level of condensed gas **62**. An embodiment of condensate trap **24** may include a closed container that accepts the gaseous products of electrolysis produced in electrolysis unit **18**. This gaseous product may be a type of aerosol, and when it arrives in the container via hydrogen and oxygen fuel line **36**, the outside temperature and the heat of the gas produces water condensate **62** consisting substantially of water, in addition to fuel gas **64**. The pressure of the fuel gas **64**, which consists substantially of hydrogen and oxygen, may force moisture to separate and drop to the bottom of water condensate trap **24** as a condensate which in turn forms into a liquid water condensate **62**. As this liquid rises, at a certain level it trips a condenser float switch **60** or electronic valve in the floor, and the condensate liquid **62** exits through a water dump tube **66** in the floor of the trap **24**. In the meantime, the hydrogen and oxygen gasses rise and move through external fuel output **40** into the air intake of the internal combustion engine. An electronic condenser valve **70**, in response to a signal from condenser float switch **60**, may open to dump the water condensate **62** out of the system through a condenser output tube **72**.

[0027] Embodiments may include an oxygen sensor **68** in line with the external fuel output **40**, as may be mandated by the Environmental Protection Agency. Embodiments of the system may include a special chip or other sensor component to assist in oxygen detection. When high oxygen levels are detected, a control system may regulate the production of oxygen.

[0028] As depicted in the embodiment of FIGS. **3**A and **3**B, an electrolysis unit **18** may include a number of plates including positive plates **80**, negative plates **82**, and neutral plates **84**. As depicted in FIG. **3**A, the plates may be organized as +NN−NN+, with positive plates **80** electrically connected to the positive lead **88** and negative plates **82** electrically connected to the negative lead **90**, and with two neutral plates between each positive and negative plate. Other embodiments may include, for example, −NN+NN−NN+NN−, −NNN+NNN−NNN+NN−, or −NN+NN−. Additional configurations may be made. A positive lead **88** may electrically connect the positive plates **80**, which have a tab in a first orientation such as tab up, and a negative lead **90** may electrically connect the negative plates **82**, which may be similar to the positive plates except that they are in a second orientation such as tab down. One or more electrolysis input sockets **94** in the front of the electrolysis unit **18** may connect to the electrolysis recharge line **32** near the bottom of the electrolysis unit **18** to receive electrolyte from the reservoir. The acetic acid may be forced into the electrolysis unit **18** under pressure by the circulation pump, which will help blow the bubbles of hydrogen and oxygen gas off of the plates, helping enhance hydrolysis. One or more gas output sockets **96** in the back of the electrolysis unit may connect to the electrolysis gas line **34** to send the products of hydrolysis to the reservoir. The output sockets **96** may be located approximately 1.5 inches from the top of the electrolysis unit, so as to extract the gasses produced by hydrolysis, and also to uptake the electrolyte when the unit is full of electrolyte (thereby helping make room for gasses in the electrolysis unit as gasses are produced).

[0029] As depicted in FIGS. **4**A, **4**B, and **4**C, plates **80**, **82**, and **84** have gaskets **92** for insulation between the plates. Positive plates **80** have a tab in a first orientation such as tab up, and negative plates **82** may be similar to the positive plates except that they are in a second orientation such as tab down. Neutral plates **84** may help provide space between alternating positive and negative plates in the electrolysis unit.

[0030] Embodiments of the present invention may be packaged in a single housing, and all elements kept within, except wires and tubes and the dashboard unit. The package may be steel for automobiles or plastic for trucks. In automobiles, the package may be located in the trunk. In trucks, or diesels, the package may be bolted to the frame.

I claim:

1. A device for producing a gas, comprising:
an electrolyte;
an electrolysis unit that retains the electrolyte;
a cathode inside the electrolysis unit;
a positive lead electrically connected to the cathode;
an anode inside the electrolysis unit;
a negative lead electrically connected to the anode;
a neutral element inside the electrolysis unit, between the cathode and anode;
a pulse width modulator that provides pulse-width-modulated power to the leads so that the cathode and anode react with the electrolyte to produce a gas;
a first conduit that transports gas and electrolyte in the electrolysis unit to a reservoir;
a second conduit that transports the electrolyte in the reservoir to the electrolysis unit; and
a third conduit that transports the gas in the reservoir out of the device, thereby producing the gas.

2. The device of claim **1**, wherein the electrolyte is acetic acid, the cathode produces hydrogen, the anode produces oxygen, and the gas includes the hydrogen and the oxygen.

3. The device of claim **1**, wherein the anode is a metal plate, the cathode is a metal plate, the neutral element is a plate, and the anode, cathode, and neutral element are oriented generally parallel to each other inside the electrolysis unit.

4. The device of claim **3**, further comprising:
gaskets between the plates.

5. The device of claim **1**, wherein the anode includes iridium tin and the cathode includes iridium tin.

6. The device of claim **1**, wherein the cathode has a cathode tab, the cathode lead is connected to the cathode tab, the anode has an anode tab, and the negative lead is connected to the anode tab.

7. The device of claim **1**, further comprising:
a pump to urge the electrolyte in the reservoir through the second conduit to the electrolysis unit so that the electrolyte helps blow bubbles of gas produced by the anode and the cathode off of the anode and the cathode.

8. The device of claim **1**, further comprising:
a condensate trap that receives gas from the reservoir, dumps condensate that condenses from the gas out of the trap, and provides the gas to the third conduit to be transported out of the device.

9. The device of claim **1**, further comprising:
a water reserve that contains water; and
a sensor that determines the level of electrolyte in the reservoir;
wherein, when the sensor determines that the level of electrolyte in the reservoir is low, water in the reserve is provided to the reservoir so as to raise the level of electrolyte.

10. The device of claim 1, wherein the third conduit is adapted to produce the gas to the air intake of an engine, and the pulse width modulator is adapted to obtain direct current power from a battery.

11. The device of claim 1, further comprising:

a display screen that provides device status to a user; and

a control input that provides an input from the user to the pulse width modulator.

12. A device for producing a gas, comprising:

an electrolysis unit that retains an electrolyte, the electrolyte including acetic acid;

a cathode inside the electrolysis unit, having a metal plate and a cathode tab electrically connected to a positive lead;

an anode inside the electrolysis unit, having a metal plate and an anode tab electrically connected to a negative lead;

a neutral plate between the cathode and anode, the anode, cathode, and neutral plate oriented generally parallel to each other inside the electrolysis unit;

a plurality of gaskets between the plates;

a pulse width modulator that provides pulse-width-modulated power to the leads so that the cathode and anode react with the electrolyte to produce a gas that includes hydrogen and oxygen;

a first conduit that transports gas and electrolyte in the electrolysis unit to a reservoir;

a second conduit that transports the electrolyte in the reservoir to the electrolysis unit; and

a third conduit that transports the gas in the reservoir out of the device, thereby producing the gas.

13. The device of claim 12, further comprising:

a pump to urge the electrolyte in the reservoir through the second conduit to the electrolysis unit so that the electrolyte helps blow hydrogen bubbles off of the cathode plate and oxygen bubbles off of the anode plate.

14. The device of claim 12, further comprising:

a condensate trap that receives hydrogen gas and oxygen gas from the reservoir, dumps water that condenses from the gasses out of the trap, and provides the gasses to the third conduit to be transported out of the device.

15. The device of claim 12, further comprising:

a water reserve that provides distilled water to the reservoir when electrolyte in the reservoir is low.

16. The device of claim 12, further comprising:

a dashboard unit, electrically connected to the pulse width modulator, having a status display screen and a control input.

17. The device of claim 12, further comprising:

a dashboard unit, electrically connected to the pulse width modulator, having a status display screen and a control input.

18. A method of producing a gas, comprising:

providing an electrolysis unit having a cathode, an anode, a neutral element between the cathode and anode, gaskets therebetween, and an electrolyte including acetic acid;

applying pulse-width-modulated power to the cathode and anode to produce gas from the electrolyte, the gas substantially containing hydrogen and oxygen;

transporting the gas and some of the electrolyte from the electrolysis unit to a reservoir;

transporting the electrolyte in the reservoir back to the electrolysis unit, thereby reusing the electrolyte;

refilling the reservoir with distilled water when the level of electrolyte in the reservoir is low;

utilizing a condensate trap to dump water that condenses out of the gas in the reservoir; and

transporting the gas in the condensate trap for use, thereby producing the gas.

19. The method of claim 18, further comprising:

pumping the electrolyte in the reservoir into the electrolysis unit to help enhance hydrolysis.

20. The method of claim 18, further comprising:

transporting the gas that is produced to an air intake of an engine for a vehicle having a battery; and

powering the electrolysis unit utilizing power from the battery so that the gas is produced when the vehicle is on.

* * * * *